CPSC 314
Computer Graphics

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A first look at OpenGL, and Geometry

Many slides courtesy of Min Hyuk Kim, KAIST and Steven Gortler, Harvard

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Preliminaries

- Connect, Piazza ok?
- Pickup prerequisite letters
Today

- What are WebGL/OpenGL?
- Three.js?

What is OpenGL/WebGL?

- OpenGL = Open Graphics Library
  - An open industry-standard API for hardware accelerated graphics drawing
  - Implemented by graphics-card vendors
  - Maintained by the Khronos group
- OpenGL ES = Embedded Systems version of OpenGL with reduced functions
- WebGL 1.0 is based on OpenGL ES 2.0, accessible from JavaScript
- Same underlying graphics architecture
What is OpenGL?

Pros & Cons:
- Full specification freely available
- Everyone can use it
- Can use it anywhere (Windows, Linux, Mac, BSD, Mobile phones, Web-pages, ...)
- Long-term maintenance for older applications
- New functionality usually available earlier through Extensions
- Inclusion of Extensions to core may take longer
- Game-Industry

OpenGL Pipeline

Reference:
Textbook Chapter 1

Shapes are “discretized” into primitives:
triangles, line segments, ...
We’ll focus on triangles most of the time
OpenGL Pipeline: Vertex Shader

- Vertices are stored in a vertex buffer.
- When a draw call is issued, each of the vertices passes through the vertex shader.
- On input to the vertex shader, each vertex (black) has associated attributes.
- On output, each vertex (cyan) has a value for gl_Position and for its varying variables.

OpenGL Pipeline: Rasterization

- The data in gl_Position are used to place the three vertices of the triangle on a virtual screen.
- The rasterizer figures out which pixels (orange) are inside the triangle and interpolates the varying variables from the vertices to each of these pixels.
Each pixel (orange) is passed through the fragment shader, which computes the final color of the pixel (pink).

The pixel is then placed in the framebuffer for display.

By changing the fragment shader, we can simulate light reflecting off of different kinds of materials.
Texture Mapping

- A simple geometric object described by a small number of triangles.
- Details stored in an auxiliary image called a texture.
- Parts of the texture are glued onto each triangle giving a more complicated appearance.

A brief look at Three.js

- A high level library that can use WebGL for rendering
  - Can also use the basic HTML5 canvas for simple things
- Setup is much easier compared to WebGL
- Implements “scene” and “mesh” abstractions
- Mesh $\cong$ geometry + material properties
  - Warning: this usage of “mesh” is non-standard
- Scene contains a hierarchy of mesh objects
- Render a scene using a Camera
**Summary**

- What is OpenGL/WebGL?
  - A software interface that allows a programmer to communicate with the graphics hardware
  - A programming interface for rendering 2D and 3D graphics
  - A cross-language multi-platform API for computer graphics
- What is Three.js
  - A high level JavaScript library that provides easy setup and access to WebGL

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**Demo**

http://mrdoob.com/projects/htmleditor/